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Impact of operational conditions and reactor configuration on process performance and microbial community in short solid retention time EBPR systems

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1. INTRODUCTION

Current research promotes resource recovery using different strategies:

- Energy recovery using A-stage systems [1]
- Phosphorus recovery using low SRT EBPR systems [2,3]
- To minimize ammonia oxidation, so it can assimilated by phototrophic organisms [2]
- Water reuse for "fertigation" [2-4]

Common element: short SRT EBPR systems

Optimal N-to-P ratio

Fertigation

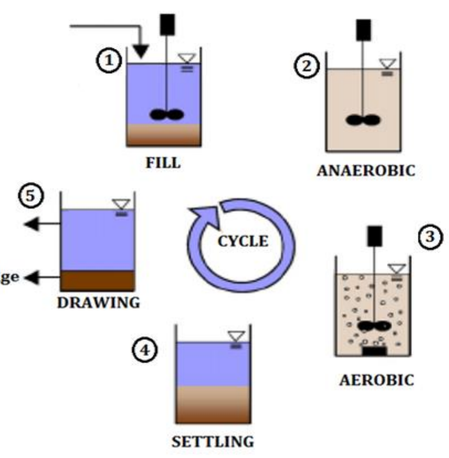
2. OBJECTIVES

- To assess the **start-up** operation of a short SRT EBPR system
- To **define** the **microbial community** affecting the performance of the short SRT EBPR system
- To **test** the process performance **stability** in two different **configurations**:
  - ➢ *Sequencing batch reactor (SBR)*
  - ➢ *Continuous flow system*

3. RESULTS

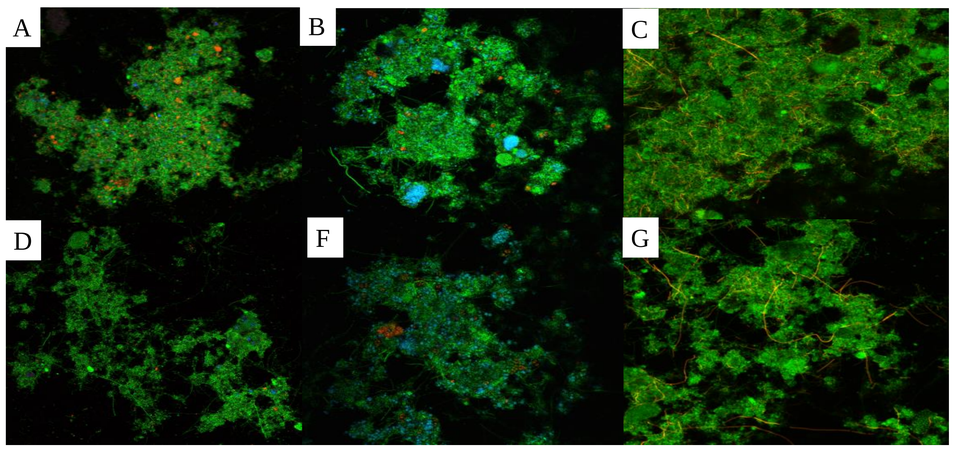
Sequencing Batch Reactor:

- Stable operation at SRT 8 days (day 50).
- Incomplete nitrification when the SRT was shifted to 5 days (data not shown)
- Filamentous bulking after nitrifiers were washed out at SRT=4 days
- qFISH revealed high abundance of *M. parvicella* (7%) and *Thiothrix* (17%) at relatively low DO levels in aerobic phase

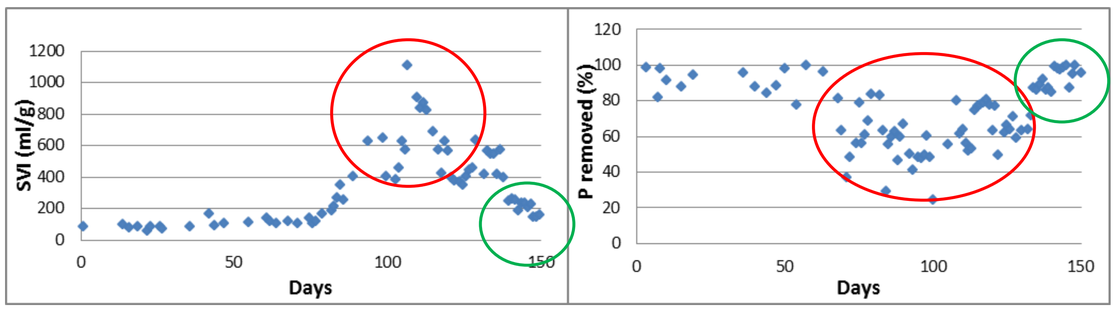


Filamentous bulking starts

20 days after PAOs are washed out

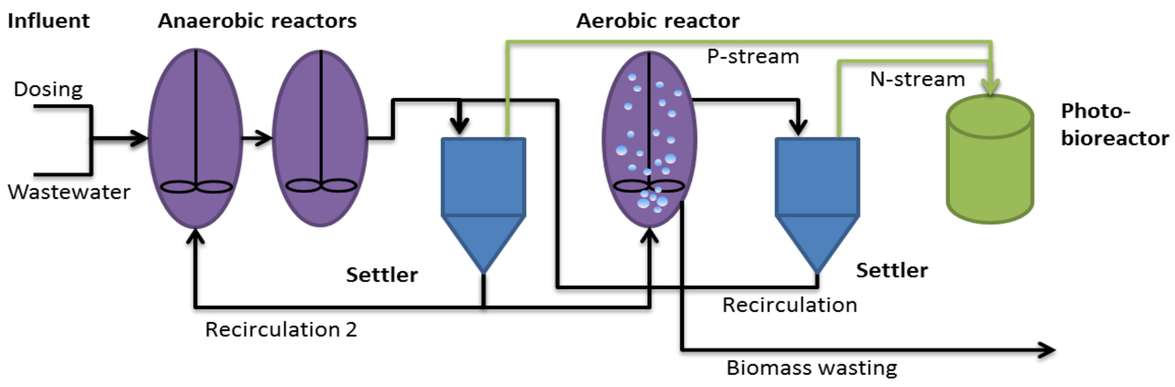


Microbial community when the filamentous bulking was detected (upside pictures) and 20 days after (down side pictures). A and B) Accumulibacter (red) and Tetrasphaera (blue); C) and D) Competibacter (blue) and Defluvicoccus (red); E) and F) M. parvicella (red). Total bacteria are shown in green.

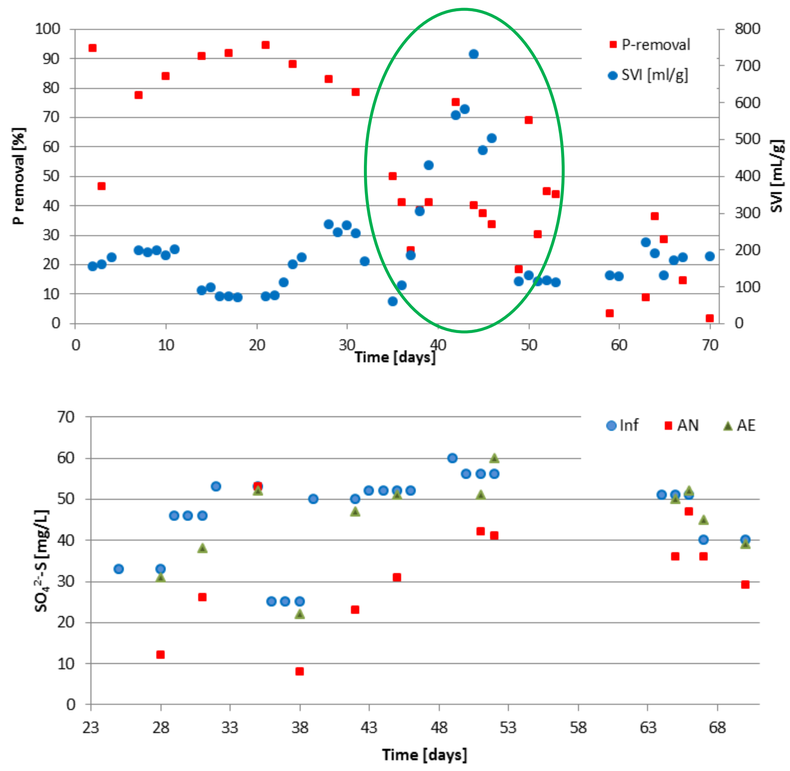


- **Bulking** correlates with **poor phosphate removal** (highlighted in red)
- **High abundance** of ***Thiothrix*** filamentous bacteria
- **Sulfate reduction** during the anaerobic phase (about 30% of influent sulfate)
- **Sulfate reducers** outcompeted **PAOs** by **competing for influent COD**
- **Sulfate reducers** were **outcompeted** by **reducing** the **anaerobic** phase length (highlighted in green)

Continuous flow system:



- Filamentous **bulking** occurred at **SRT 8 days**
- **Bulking** corresponded with **poor phosphorus removal** and high ***Thiothrix*** abundance (Sulfate reduction correlated with **SVI** and **P-removal**)
- **Action taken**: The **anaerobic HRT** was **reduced** to phase out the SBRs:
  - ➢ Significant reduction in SVI;
  - ➢ Significant reduction in sulfate reduction;
  - ➢ P-removal, however, was not recovered



4. CONCLUSIONS

- Low SRT EBPR systems are **sensitive** to bulking due to ***Thiothrix*** and ***M. parvicella***
  - **SBR** is **more robust** due to imposed substrate gradients
- **Sulfate reducers compete** with **PAOs** for **volatile fatty acids** (via completed or uncompleted oxidation)
- **Sulfate reducers** can be controlled by manipulating the **anaerobic HRT**

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